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(54) Channel de-allocation in discontinuous transmission mode

(57) When a voice activity detector in a mobile senses a period of silence, the mobile enters a discontinuous transmission mode (DTX) in which it normally sends a "SPEECH-OFF" message or packet periodically to a base station. A DTX timer in the base station is started 64 or reset 67 on receiving a SPEECH-OFF message. If no such message is received for a period long enough for the DTX timer to time out 68, the base transmits a "SEND SPEECH" message 69. If the base does not receive speech 71 or a SPEECH-OFF message 73 within a certain time 70 following the SEND SPEECH message, it is assumed that the mobile is out of range and the base station will then de-allocate the channel in use 74, freeing it for use by another mobile. The channel may also be de-allocated if the mobile has been in the discontinuous mode for greater than a threshold time. The base may transmit a message warning that channel de-allocation is to occur, and the mobile may then send speech or some other message indicating that the channel should not be de-allocated.

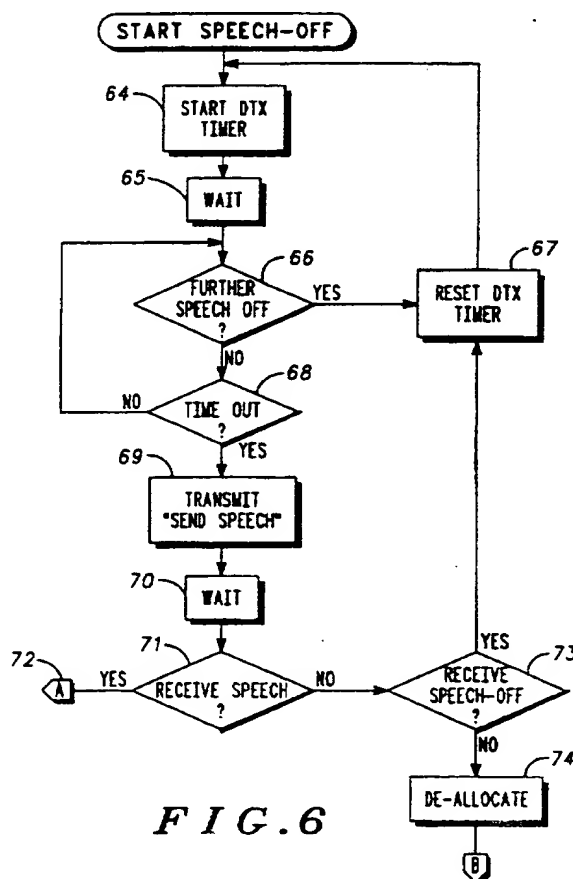


FIG. 6

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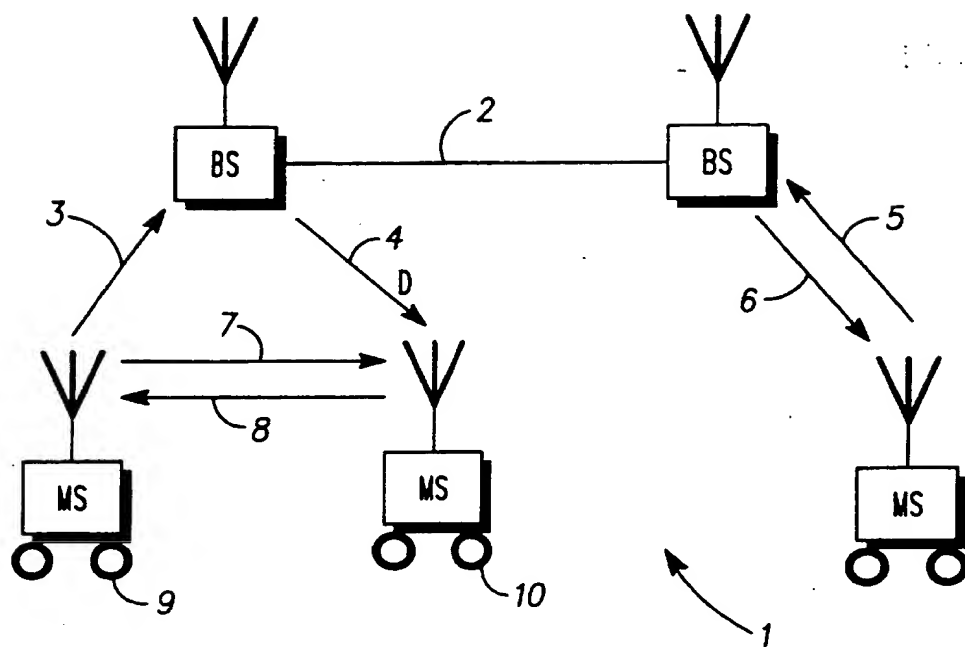


FIG. 1
— PRIOR ART —

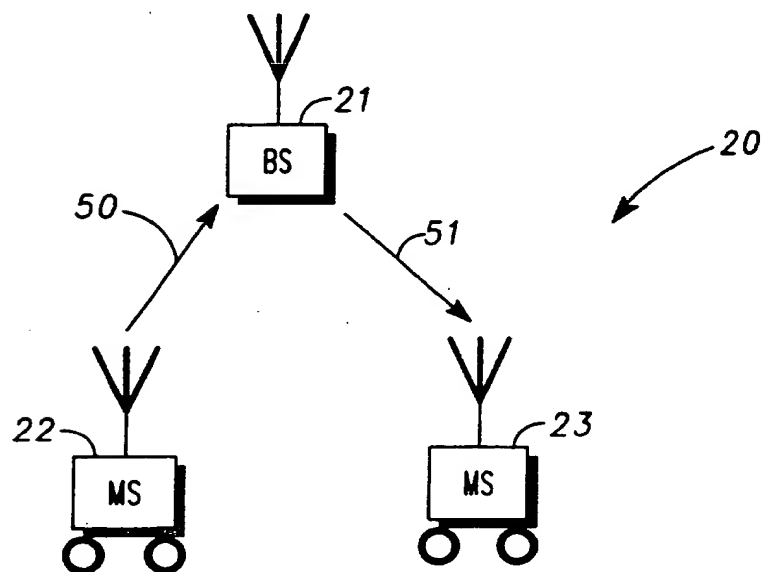


FIG. 2

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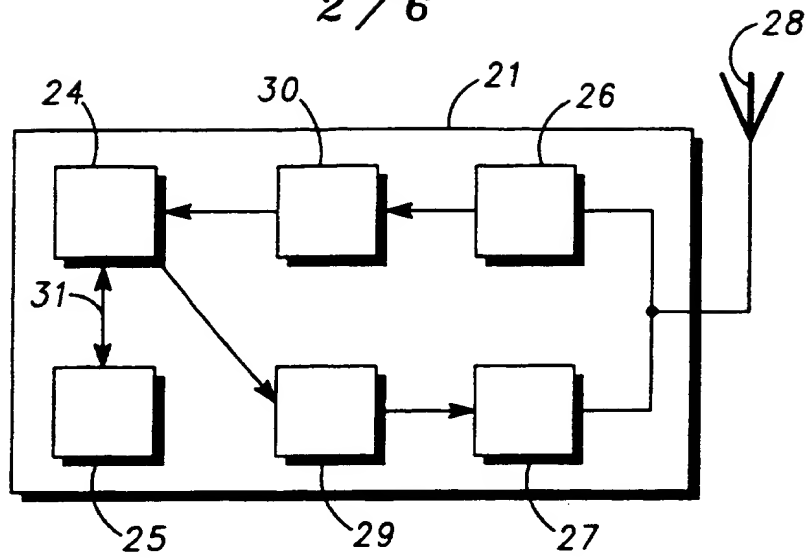


FIG. 3

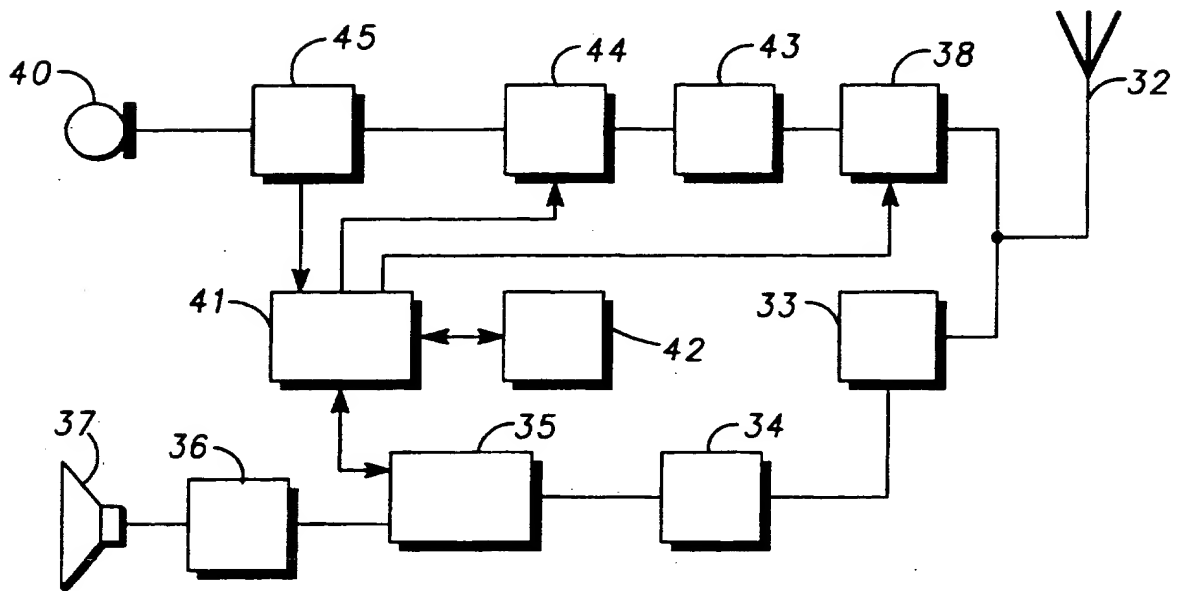


FIG. 4

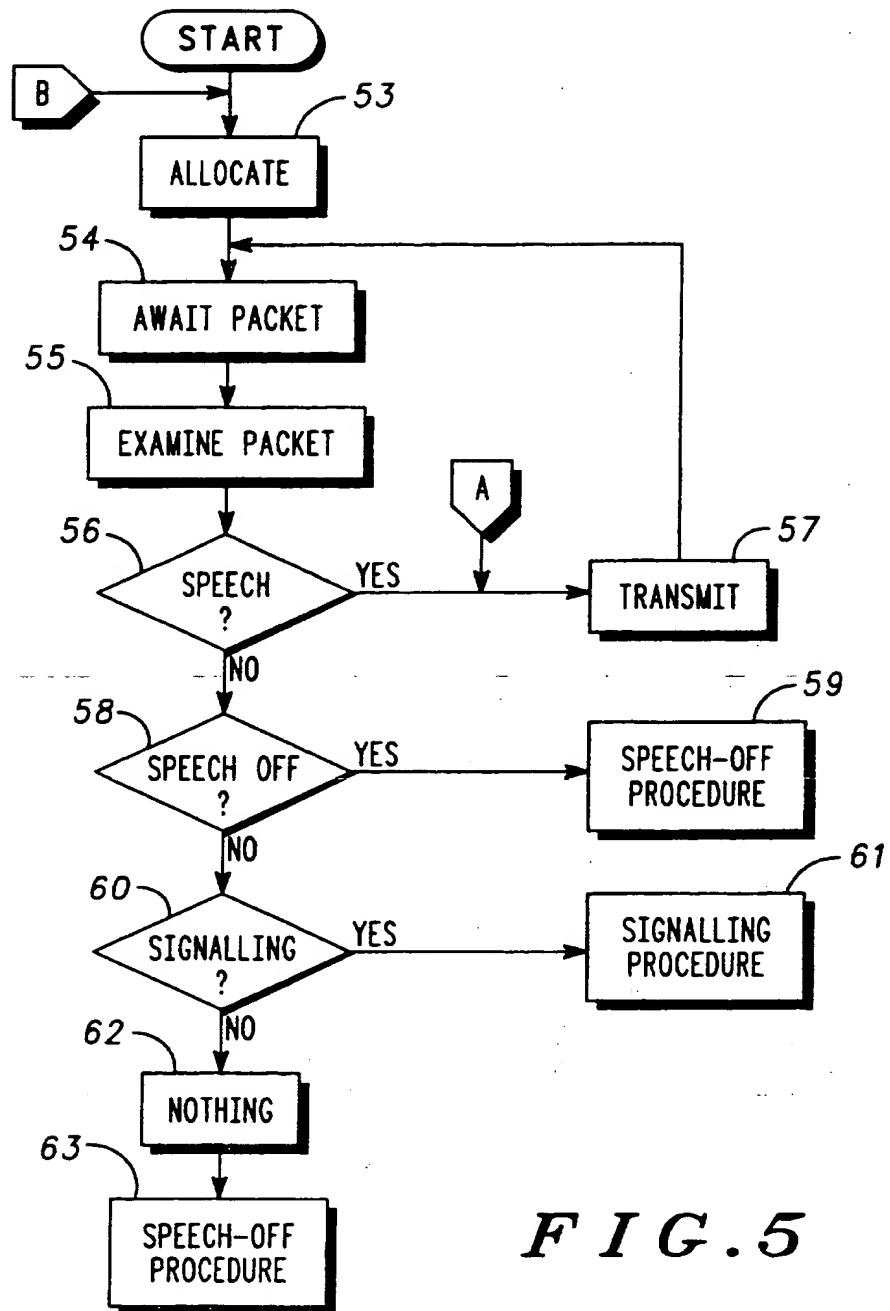
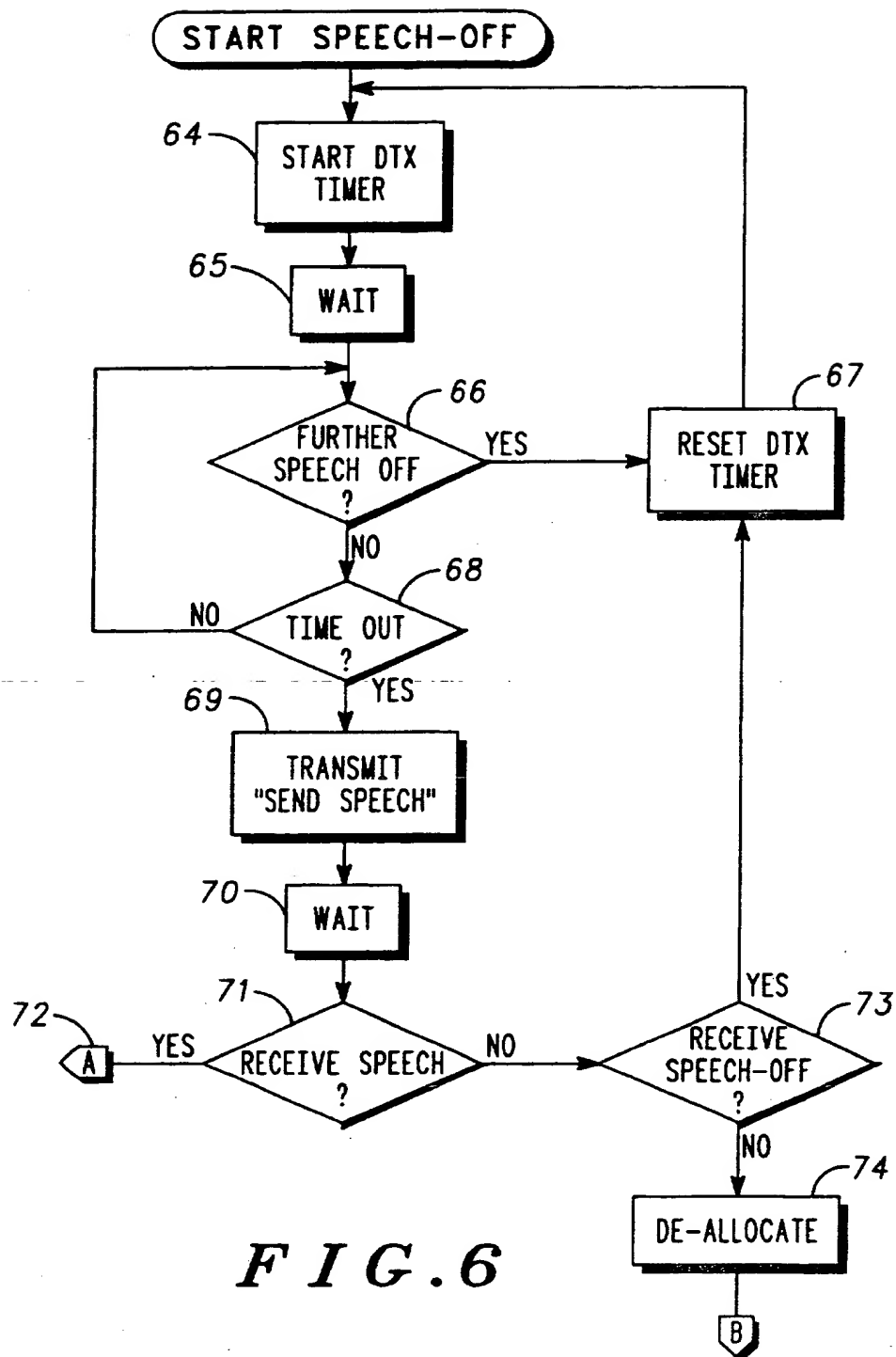
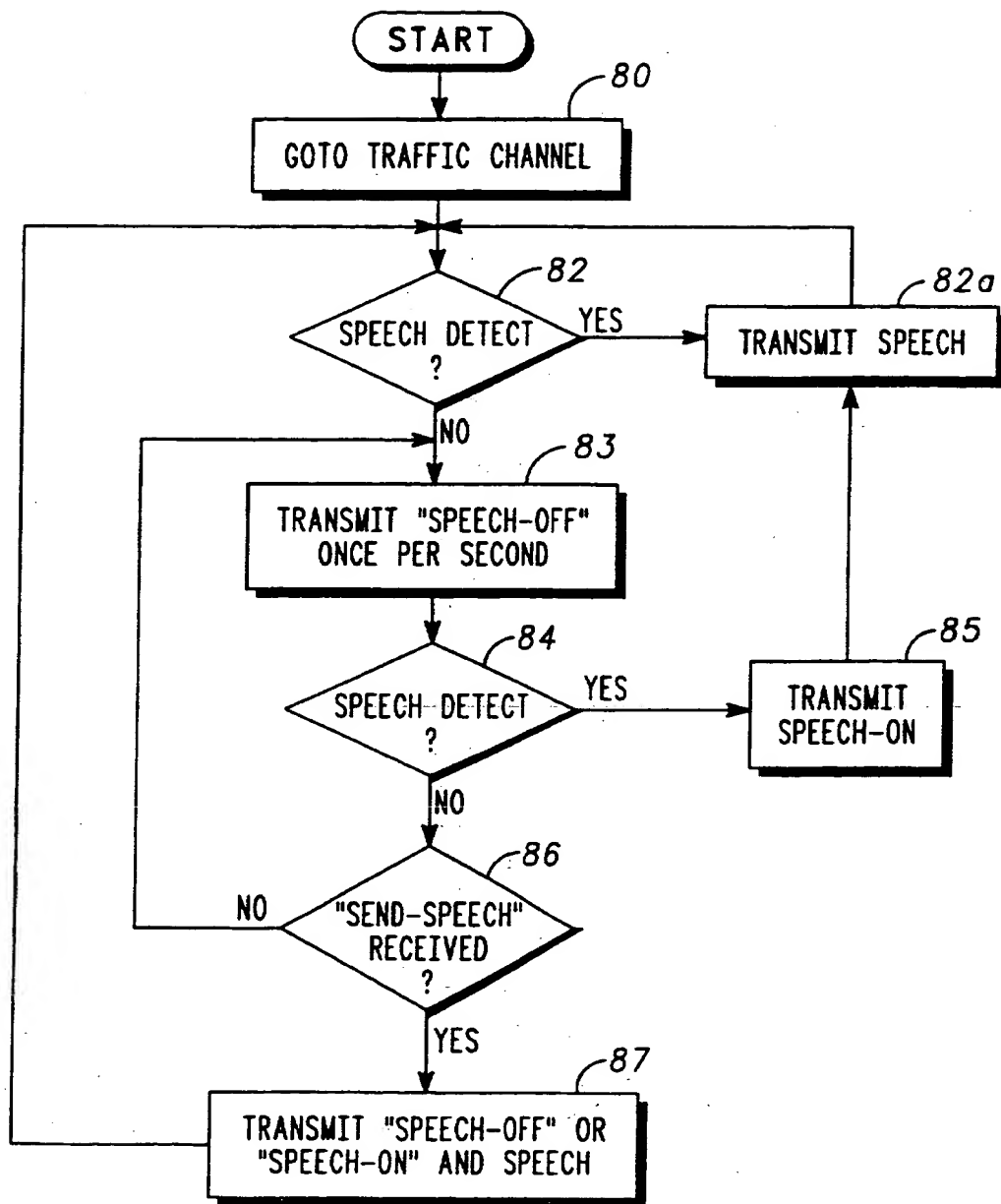


FIG. 5



*FIG. 7*

TIME →

CONTINUOUS MODE

DTX MODE

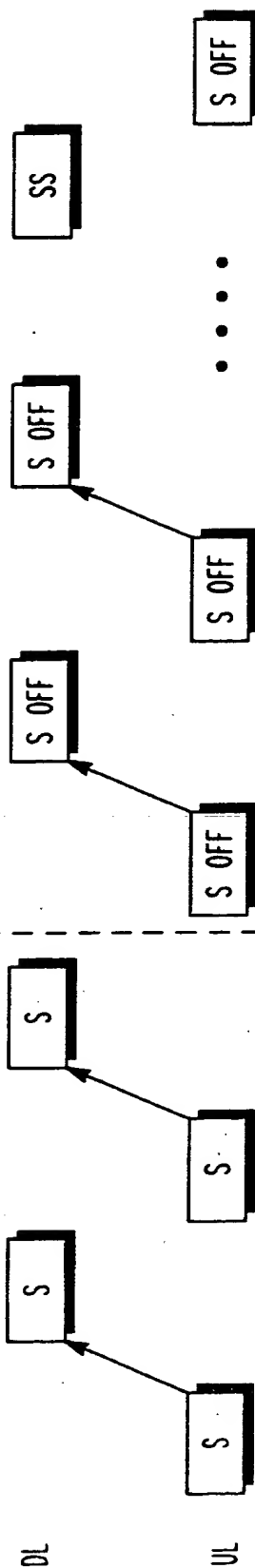


FIG. 8

A COMMUNICATION METHOD

Field of the Invention

5 This invention relates to a communication method particularly, but nor exclusively, for use in a radio communication system.

Background of the Invention

10 Typical radio communication systems comprise one or more base-stations serving a large number of mobile or hand-held radio transceivers.

 Broadly speaking there are usually two modes of communication possible in such systems. In direct mode a mobile or hand-held transceiver communicates directly to another transceiver whilst in trunk
15 mode the mobile will communicate using a base-station as an intermediary or relay.

 Prior art Fig. 1 shows a typical radio communication system 1 comprising a pair of base-stations labelled B.S. and three mobile radio transceivers labelled M.s. The base stations are connected together by a
20 wire line 2 along which signalling and data may flow thus allowing the base stations to communicate.

 Arrows labelled 3 to 8 represent communication links, the heads of the arrows indicating the direction of information flow. It will be seen that mobiles 9 and 10 have two alternatives for communication.

25 The first alternative is to communicate via a base station by links 3 and 4. This is the earlier referred to trunk-mode. Link 3 is referred to as an up-link and link 4 is referred to as a down-link.

 The second alternative is the earlier referred to direct-mode and utilises links 7 and 8.

30 It will be appreciated that during communication between two individuals there occur considerable periods of silence. It is a waste of the system's resources and battery power of a transmitting mobile to transmit these periods of silence.

 The absence of speech is detected by the mobile and it sends a signal
35 or message to the base-station appropriately called "SPEECH-OFF".

 To indicate to the base-station that the mobile is still operating and is in the coverage range, the "SPEECH-OFF" message is periodically repeated (typically one message per second). This mode is referred to in the art as discontinuous transmission mode (DTX).

A problem that occurs with the above described communication method is that the "SPEECH-OFF" message may reach the base-station in an unreadable form because of poor reception conditions. The base-station will then assume after a period of time has elapsed without a successful receipt of a "SPEECH-OFF" message that the mobile is out of range. The base-station will then reallocate the communication channel being used and break the communication links to the mobiles.

Summary of the Invention

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According to the invention there is provided a communication method for use in a communication system comprising the steps of: establishing a communication channel between at least two of the units; communicating between the units in a first mode, communication taking place by transmission of messages of a first type; monitoring the communication to establish that information that is desired to be communicated is being communicated; in the event of establishing that the information is not being communicated switching the mode of operation to a second mode of operation in which a message of a second type indicative of the second mode is periodically transmitted; in response to receiving a message of the first type when operating in the second mode reverting to the first mode of operation; characterised by the further steps of: when operating in the second mode: monitoring for the transmission of the message of the second type and in the absence of a message being transmitted beyond a predetermined time interval transmitting a third type of message in response to which at least one of the units will send a response message of the first or second type; and in the absence of a response message for a predetermined period of time de-establishing the communication channel.

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By so requesting a response the system ensures that a unit of the system has not travelled out of range or has ceased operation and that the communication channel is not needlessly being retained for the communication. The channel can then be re-allocated for use by other units of the system.

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A specific embodiment of the invention will now be described, by way of example only, with reference to the drawings.

Brief Description Of The Drawings

5

Figure 1 shows in schematic block diagram form a prior art communication system;

10

Figure 2 shows in schematic block diagram form a communication system operating in accordance with the invention;

Figure 3 shows in schematic block diagram form a base-station of the system shown in Fig. 2;

15

Figure 4 shows in schematic block diagram form a mobile of the system; and

Figures 5 to 8 are explanatory diagrams.

20

Detailed Description of Preferred Embodiment

As is shown in FIG.2, a communication system 20 operating in accordance with the invention comprises a base-station 21 and a number of mobile radio transceivers (hereinafter referred to as mobiles) 22 and 23.

25

The base-station 21 is shown in greater detail in FIG.3 and it comprises a processor 24, a memory 25, a receiver 26, a transmitter 27, an antenna 28, a modulator 29 and a demodulator 30.

30

The processor 24 controls the operation of the base-station 21 in accordance with a program held in memory 25. The program is stored as a set of hexadecimal numbers in a set of addressable memory locations as will be well known to the man skilled in the art. The memory 25 also holds data written to it by the processor 24. Thus, the two components are linked by a two-way data-bus 31.

35

The receiver 26 is an electronic circuit which receives signals picked up by the antenna 28. The received signals are passed to the demodulator

30 which demodulates the signals to retrieve the transmitted information before passing the information to the processor 24.

The modulator 29 receives information from the processor 29 and creates a modulated signal which is passed to the transmitter ~~27~~.

5 The transmitter 27 amplifies the modulated signal and passes it to the antenna 28 from which it is transmitted to the other units in the system.

The processor 29 of the base-station 21 performs a management function for the system controlling the allocation of communication channels and provides the "intelligence" for the operation of the inventive method to which this specification is directed.

The mobiles are nominally identical and the following description of mobile 22 will be equally applicable to mobile 23.

15 Mobile 22 is shown in greater detail in FIG. 4. It comprises an antenna 32, a receiver 33, a demodulator 34, a speech decoder 35, an audio-output amplifier 36, a speaker 37, a transmitter 38, a microphone 40, a processor 41 and a memory 42, a modulator 43, a speech coder 44, and a voice activity detector 45 (hereinafter referred to as the VAD).

20 The processor 41 is a microprocessor which operates in accordance with a program stored in memory 42. Memory 42 also acts as a storage area for data generated by the processor or directed thereto. The two components are connected by a two way data bus to permit the data interchange. The processor 41 provides the "intelligence" of the mobile 22 and is thus connected to a number of the other components in this case to the VAD 45, the speech coder 44, the transmitter 38 and the speech decoder 36.

The basic transmit receive operation of the mobile 22 will be familiar to those skilled in the art of radio design and will thus only be described briefly.

30 Microphone 40 will convert sound into electrical signals which are passed to the VAD 45. The VAD 45 produces a signal which is input to the processor 41 if speech is detected (by for example the VAD 45 comparing the sound signals with a predetermined threshold signal level). The sound signals are passed by the VAD 45 to a speech coder 44 which encodes the speech in a well known manner. The encoded speech is passed to the modulator 43 where it is modulated. The modulated encoded speech is

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then passed to the transmitter 38 where it is amplified and transmitted via antenna 32 to the rest of the system.

When receiving signals from the rest of the system, the antenna 32 passes the r.f. signals to receiver 33 where the required signals are
5 isolated. These signals are input into the demodulator 34 where they are demodulated. The demodulated signals are passed to the speech decoder 35 where they are decoded to provide the speech signals. The speech signals are then amplified by the power amplifier 36 before being fed to speaker 37.

10 The operation of the system will first be broadly described to give an overview before being described in detail.

Mobile 22 wishes to communicate with mobile 23. Direct communication is not possible (or not desired) so a trunk call is required. The communication path is via uplink 50, between mobile 22 and the base-station 21, and down link 51 between base-station 21 and mobile 23. The air
15 interface communication uses time division multiple access.

The operation will now be described in greater detail with reference to the flow diagram of FIG.5. This flow diagram shows the operation of the base-station 21. In a first step 53 the base-station 21 receives a connection request from mobile 22, which wishes to communicate via the base-station
20 with the mobile 23, and allocates the necessary radio channels. If the call is a simplex call one channel is allocated by the base-station. The up-link is allocated to the transmitting mobile Ms 22 and the down-link of the channel allocated to the mobile Ms 23. In essence, the base-station 21 establishes the up-link (UL) 50 and the down-link (DL) 51. For the duplex
25 case, two channels would be allocated the up-link and down-link to Ms 22 and an up-link and down-link to Ms 23.

For this connection the base-station 21 will act as a relay receiving packets from a mobile and then retransmitting them to the other mobile.

The base-station 21 after having established the communication
30 channel awaits a packet from one of the mobiles 22, 23 in step 54. Let us suppose that it receives the first packet from mobile 22 which is likely because it initiated the call connection. The base-station 21 then examines the packet in step 55. In decision diamond 56 consideration is given to whether the packet is of a type containing speech information, if it is then
35 step 57 is performed in which the packet is retransmitted by the base-station 21 via the down-link 51 to mobile 23.

If the packet is not a speech packet then the processor of the base-station 21 considers whether the packet is a speech-off packet in decision step 58. If the packet is a speech off packet then the speech-off procedures are carried out in step 59. These procedures will be described later.

5 If the packet is not a speech-off packet then consideration is given as to whether the packet is a signalling packet in decision step 60. If the packet is a signalling packet then signalling procedures are then carried out in step 61. These procedures will not be described in detail but they may involve establishing further connections or changing channels or the
10 such.

 If the packet is not a signalling packet then the base station determines that no packet has been sent in step 62. The next step will be the initiation of the speech-off procedures in step 63.

 The speech-off procedure initiated at steps 59 and 63 will now be
15 described with reference to FIG.6. In a first step, step 64, the processor of the base-station 21 starts a discontinuous trunk transmission (DTX) timer. The processor waits in step 65 for a predetermined period of time and then considers in step 66 whether a further speech-off packet has been received. If the answer is yes, then the next step is step 67 in which the DTX timer is
20 reset and restarted by returning to step 64.

 If a further speech-off packet has not been received then consideration is given in step 68 as to whether the time recorded on the DTX timer has exceeded a predetermined threshold. If it has, then a time-out condition is reached.

25 If a time-out condition has not been reached then the next step is step 66.

 If a time-out condition has been reached then the next step is step 69 which is a send send-speech step. In this step the base station 21 transmits a packet to the mobile station requesting transmission of speech.
30 The base station 21 then waits for a response in step 70.

 Consideration is next given in step 71 as to whether or not a speech packet is received. If a speech packet is received then a next step, step 72, is to return to point labelled A in FIG. 5, that is to say, the next step is step 57 in which the speech packet is retransmitted on the down-link 51.

35 If no speech is received then consideration is given in step 73 as to whether or not a speech-off packet has been received.

If a speech-off packet is received then the next step is step 67 in which the DTX timer is reset and then restarted in step 64.

If a speech-off packet is not received then the next step is to de-allocate the channel, step 74. In this step the channel allocated for the
 5 connection between mobiles 22 and 23 is re-used for some other communication connection.

Thus, it will now be understood that the base-station sets up a connection between the two mobiles and then relays packets between them. Should one of the mobiles enter a speech-off mode which is a discontinuous
 10 transmission mode in which packets are only periodically sent then, the base-station will monitor that they are regularly received. If they are not a time-out condition occurs and the base-station 21 requests a packet. This ensures that if the mobile is still in communication range it will send a packet and the channel will be maintained. If no packet is received the
 15 base-station will "realise" that the mobile is out of range or switched off and it will clear-down the channel freeing it for use by other mobiles.

Reference will now be made to FIG. 7 which is a flow diagram of the mobile operation. The steps thereby illustrated are carried out by the processor of the mobile.

20 A first step 80, is for the mobile to transmit speech on the traffic channel allocated by the base-station 21. In a second step 82, consideration is given as to whether or not a pause has occurred where a user of the mobile is not speaking. If a pause has occurred then the mobile will enter a discontinuous transmission mode. The speech or absence of it is detected
 25 by the VAD 45.

If speech is detected then the speech is transmitted in speech packets in step 82a and then step 82 is repeated. If speech is not detected then the mobile transmits the earlier referred to speech-off packet in step 83 repeatedly transmitting one packet per second.

30 In the next step 84 consideration is given again as to whether the user is speaking. If speech is detected then, a speech-on packet is transmitted in step 85 and the next step is step 82a.

If speech is not detected then consideration is given in step 86 as to whether the base-station has sent a send-speech packet and it has been
 35 received by the mobile. If a send-speech packet has been received then the

mobile transmits a speech-off packet or a speech-on and speech packets in step 87. The next step will then be a return to step 82.

5 If a send-speech packet has not been received then the next step after step 86 will be step 83.

FIG.8, shows a comparison of the traffic on the up and down links. During the continuous mode operation, speech packets, labelled S, are periodically transmitted on the up-link (the system is a TDMA system).
 10 These are retransmitted onto the down link by the base-station 21. When the mobile detects a pause in the user's speech, that is to say, a period of silence it initiates a discontinuous transmission mode in which a speech-off packet, labelled S OFF is periodically transmitted. These are retransmitted on the down-link DL by the base-station 21. If there is a
 15 break in the reception of the speech-off packets by the base-station as indicated by the dotted line, then the base-station transmits on the down-link a send-speech packet. If the mobile is within range it responds by sending either a speech-off packet (as illustrated) or a speech packet.

20 During DTX mode packets transmitted by other units in the system may be interleaved thus using the channel as fully as possible. These packets may include voice or data information. Non-voice packets generated by the base-station or the mobiles Ms 22 or Ms23 may also be interleaved.

25 Whilst in this embodiment of the invention the air interface uses TDMA other protocols may be used such frequency division multiple access FDMA.

30 It will be appreciated that a situation may arise where a unit continues to transmit in DTX mode tying up a channel perhaps unnecessarily. Thus preferably the base-station will after a predetermined threshold of time during which a unit has operated in DTX de-allocate the channel. A further enhancement to this preferred alternative would involve the base-station sending a message warning that de-allocation is to occur. The unit
 35 could then send speech or some other message indicating that the channel should not be de-allocated.

Claims

1. A communication method for use in a communication system having at least two communication units operable in a first and a second mode which method comprising the steps of:
 - 5 establishing a communication channel between at least two of the units;
 - communicating between the units in a first mode, communication taking place by transmission of messages of a first type;
 - 10 monitoring the communication to establish that information that is desired to be communicated is being communicated;
 - in the event of establishing that the information is not being communicated switching the mode of operation to a second mode of operation in which a message of a second type indicative of the second
 - 15 mode is periodically transmitted;
 - in response to receiving a message of the first type when operating in the second mode reverting to the first mode of operation;
 - characterised by the further steps of:
 - when operating in the second mode:
 - 20 monitoring for the transmission of the message of the second type and in the absence of a message being transmitted beyond a predetermined time interval transmitting a third type of message in response to which at least one of the units will send a response message of the first or second type; and
 - 25 in the absence of a response message for a predetermined period of time de-establishing the communication channel.
2. A method as claimed in claim 1 wherein messages of the first or second type are interleaved with the second type messages during the
- 30 second mode of operation.
3. A method as claimed in claim 1 or claim 2 wherein the length of time that the second mode of operation has been operating is determined and if it exceeds a threshold de-establishing the communication channel.

4. A method as claimed in claim 1 or claim 3 wherein a fourth message indicating that the communication channel is to be de-established is transmitted.
- 5 5. A method as claimed in claim 4 wherein the step of de-establishing the communication channel is suspended by receipt of a message in response to the fourth message.
6. A communication method substantially as hereinbefore described
10 with reference to and as illustrated by the drawings.



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Claims searched: 1 to 6

Examiner: M J Billing
Date of search: 9 July 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK Cl (Ed.O): H4L LDLX, LDM, LDSJ, LDSX.
Int Cl (Ed.6): H04B 7/26; H04Q 7/28, 7/30, 7/38.
Other: ONLINE : WPI.

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB2288102A (MOTOROLA) - Abstract	1
A	US4751725 (MOTOROLA) - Figs.3C,3D,5-7; column 11 line 52 to column 14 line 9	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.